Earthquake Resistant Structure Base Isolation

Meena Noorzai[1], M.N.Bajad[2], Neha Dodal[3]
[1]*Post Graduate Student, Department of Civil and Structural Engineering, Sinhgad College of Engineering,*
[2,3]*Assistant Professor, Department of Civil and Structural Engineering, Sinhgad College of Engineering,*

ABSTRACT

Base isolation is a mechanism that provides earthquake resistance to the new structure. The base isolation n system decouples the building from the horizontal ground motion induced by earthquake, and offers very stiff vertical components to the base level of the superstructure in connection to substructure (foundation). It shifts the fundamental lateral period, dissipates the energy in damping , and reduces the amount of the lateral forces that transferred to the building, inter story drift, and the floor acceleration. The work deals with modeling and finite element analysis of a high damping rubber bearing displacement controlled transient analysis was done to analyses the behavior of the isolator during earthquakes

Keywords: *base isolation, high lead rubber*

INTRODUCTION

Mitigation of structural damage induced by large loads, stemming from earthquake, is of particular interest to engineers. Specifically, in seismic regions, earthquakes pose a serious threat to both the infrastructure and human lives. The protection of civil structures, including its material content and the human occupants, is without doubt a priority to the designers worldwide. The extent of protection may range from reliable operation and occupant comfort to human and structural survival. Base–isolation is one of the most widely applied structural protection technique against seismic events (Soong, 1990). Various researchers have studied the potential of base isolation under far–field and near–field earthquake (Agrawal et.al. 2006). Studies reveled that base isolation strategy performs poor under near source excitation.

ANALYTICAL PROCEDURE

MODELING PROCEDURE IN ETABS

The modeling procedure of isolated base and fixed building in ETAB and design stapes of isolated and response spectrum analysis using UBC 97 for isolated building has been carried out and seismic design procedure has been done using IS 1893:2000(part 1) for the following data is used .

Building details

- Grade of concrete M30 and steel Grade of steel Fe500
- Floor to floor height is 3.5
- Depth of foundation below GL, parapet height is 1m, slab thickness is 150 mm
- Size of columns 300X700,size of beam 300X450
- Live load of floor = 3kN/m^2 live load of roof = 1kN/m
- Site located in seismic zone 4 and for zone four Z=0.24
- Building is resting on medium soil , for that imported factor as 1
- Density of concrete =25kn/m^3
- Density of masonry wall =20kN/m^3

Using the above in (G+25) RCC frame the building has been analysed and design for fixed base and isolated bas with lead rubber bearing for earthquake forces by ETABS software.

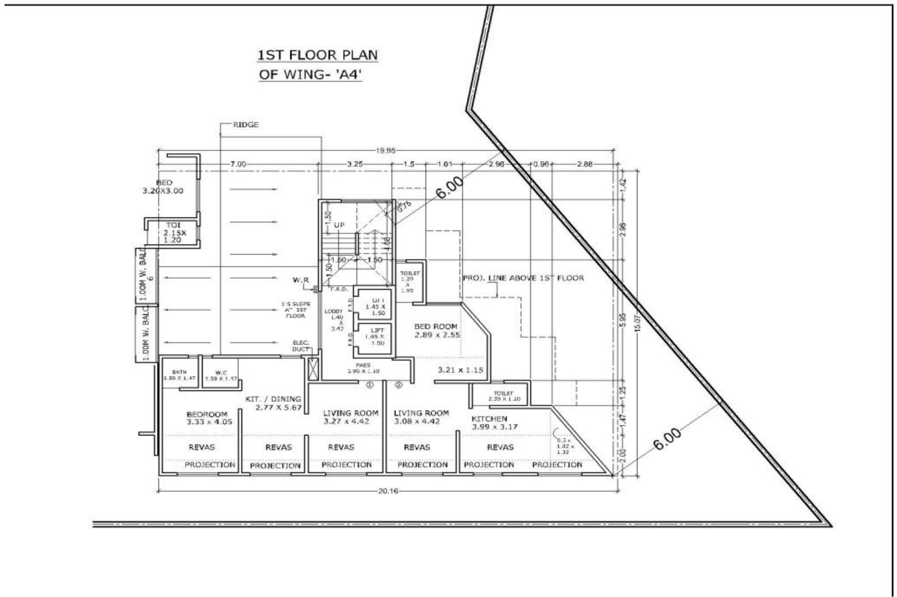


Fig.1. first floor plan for design

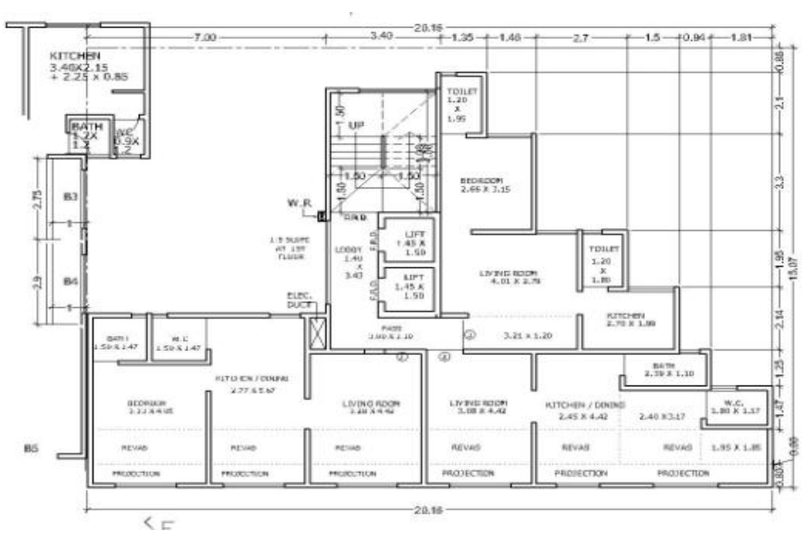


Fig.2. 2nd to 25th floor for plan

Table I
High lead rubber bearing properties

Description	
Vertical (axial) stiffness	15000K/in linear
Initial shear stiffness in each direction	20K/in
Shear yield force in each direction	7 kips
Ration of post yield	0.30

High lead rubber bearing

High Damping Rubber Bearings (HDRB) are large laminated elastomeric bearings which are ideal for seismic isolation with one device - supporting the structure, for base isolation, providing elastic restoring force and required amount of damping up to a maximum of 10-15% of critical. Moderate damping is achieved with this type of bearing. HDRB isolation bearings are vertically stiff, capable of supporting vertical gravity loads, while being laterally flexible, capable of allowing large horizontal displacements. In effect, the ground is allowed to move back and forth under a base isolated during an earthquake, while leaving the building to remain "stationary."

Also known as (HDR) has very similar appearance to lead rubber bearings, but they are totally different in nature. High damping rubber bearing is composed of special rubber with excellent damping attribute, sandwiched together with layers of steel without any lead plugs. High damping rubber bearings (HDRB) are used in bridges and structures.

Table II
High lead rubber bearing properties

Description	
Vertical (axial) stiffness	2.477kN/m linear
Initial shear stiffness in each direction	2.48kN/m
Shear yield force in each direction	138kN
Ration of post yield	0.11

Lead rubber bearing

Lead-rubber hysteretic bearings provide in a single unit the combined features of vertical load support, horizontal flexibility and energy absorbing capacity required for the base isolation of structures from earthquake attack and also Lead rubber bearings are elastomeric bearings that contain one or more lead plugs inserted into their preformed holes. The lead provides significant stiffness under service loads and low lateral loads as compare to elastomeric bearings. Advantage of lead rubber bearing Simple o manufacture ,Easy to modal and installation ,Economic design ,The more excellent safety and disadvantage is Need supplemental damping system . Lead rubber bearing is a system that is comprised of rubber and stiffening plate layers with a mechanism at the centre of the isolators made of lead to dissipate energy. the lead rubber elastomeric bearing system performed effectively in reducing acceleration in the horizontal direction. The performance of the lead-rubber bearings was effective in reducing the seismic effect onto equipment under various floor accelerations.

Suitability of seismic isolation:

Earthquake protection of structures using base isolation technique is generally suitable if the following conditions are fulfilled:

- The subsoil does not produce a predominance of long period ground motion.
- The structure is fairly squat with sufficiently high column load.
- The site permits horizontal displacements at the base of the order of 200 mm or more.
- Lateral loads due to wind are less than approximately 10% of the weight of the structure.

Result

The comparative result of 25 storied fixed base with the isolated building is made. The result is based on the analysis of fixed base structure and isolated base structure. The result comparison is made for parameter like storey displacement, story drift, lateral load in story , story shear , overturning moment, and story stiffness in x and as well as in y direction. From this it is observed that structure effective like story displacement, story drift, story lateral load, story shear, story overturning moment , and stiffness are reduced due to use of the isolator .

Table3: Story displacement in x and y direction (m)

Story No	In–x direction		In – Y direction	
	Fixed base	Base Isolated	Fixed base	Base isolated
25	0.0215	0	0.0295	0
20	0.0172	0	0.0239	0
15	0.0134	0	0.0176	0
10	0.0076	0	0.011	0
5	0.0001	0	0.0001	0
Base	0.0215	0	0.0045	0

Maxima story drift

Story drift is calculated as displacement at top storey minus displacement at the bottom storey divided by height of storey

Table4: Story drift in x and y direction (m)

Story No	In–x direction		In – Y direction	
	Fixed base	Base Isolated	Fixed base	Base isolated
25	0.000291	0	0.00037	0
20	0.000366	0	0.000427	0
15	0.000426	0	0.000458	0
10	0.000000	0	0.000456	0
5	0.000457	0	0.000078	0
Base	0.000291	0	0.00037	0

Table5: Story share in x and y direction (KN)

Story No	In–x direction		In – Y direction	
	Fixed base	Base Isolated	Fixed base	Base isolated
25	225.18	0.15	211.3	0.2
20	487.80	0.46	451.7	0.57
15	541.88	0.71	500.1	0.72
10	964.38	0.9	913.8	1.02
5	647.76	0.8	606.1	0.85
Base	225.18	0.15	211.3	0.2

Table6: Story overturning moment in x and y direction (KN-m)

Story No	In–x direction		In – Y direction	
	Fixed base	Base Isolated	Fixed base	Base isolated
25	214.912	4.304	184.3	1.484
20	3191.318	4.739	2814.511	6.694
15	6326.673	12.164	5541.087	7.292
10	14674.7	14.076	11599.28	24.721
5	8494.664	17.691	7236.225	8.302
Base	214.912	4.304	184.3	1.484

Table7: Story stiffness in x and direction (KN-m)

Story No	In–x direction		In – Y direction	
	Fixed base	Base Isolated	Fixed base	Base isolated
25	220867.58	6706.3	199402.7	1.484
20	390828.97	13488.	387916.9	6.694
15	397008.21	15164.	477001.4	7.292
10	14502897	355370	15043646	24.721
5	465868.06	16064.	735218.2	8.302
Base	220867.58	6706.3	199402.7	1.484

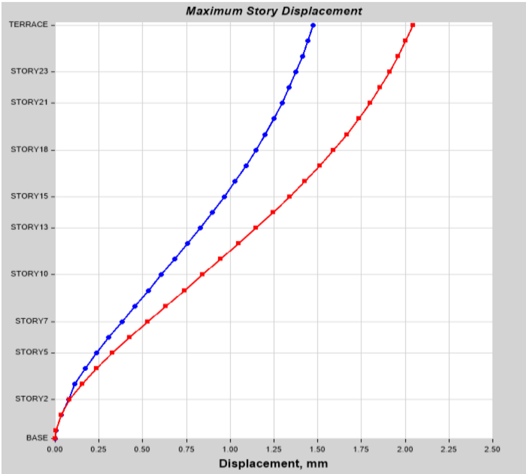


Fig.3 Displacement graph for fixed base

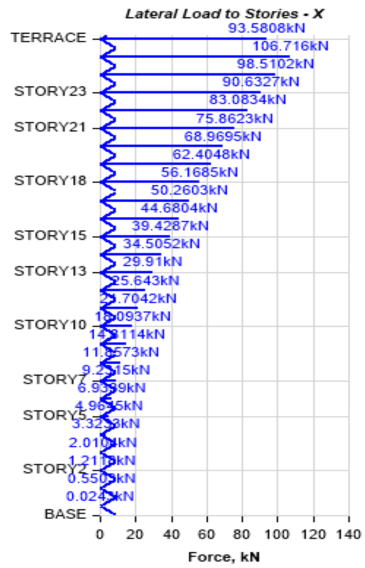
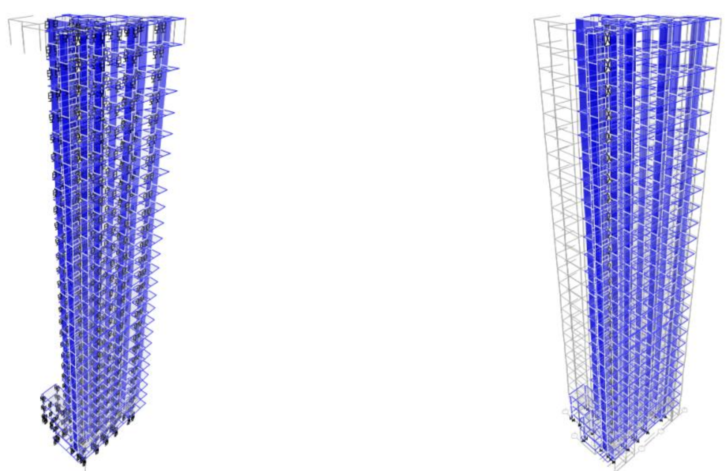


Fig.4 lateral force in story graph for fixed base

A. G .Conclusions

Based on the modeling findings, the following conclusions can be drawn:

- The main observation from the modeling study on the accuracy of seismic effect and lateral load patterns utilized in the response spectrum method analysis.
- Base-isolated structure exhibit less lateral deflection,
  Less lateral load, lass drift, less over turning moment and less stiffness values than the fixed base structure.
- The base isolation decouples the building from the earthquake-induced load, and maintain longer fundamental lateral period than that of the fixed base.



(SI) model (FB) model

Fig.5. analytical model

REFERENCES

1) C. Chia-Ming and B. F. Spencer, Jr., "An Experimental Study of Active Base Isolation Control for Seismic Protection," in Sensors and Smart Structures Technologies for Civil, Mechanical, and Aerospace Systems 2010, 8-11 March 2010, USA, 2010, p. 76473V (12 pp.).
2) Eggert, H., Kauschke, W., "Structural Bearings," Ernst & Sohn, Germany, 2002.
3) G.-F. Zhao and Y.-H. Ma, "Parameters study of rural buildings structures supported on slide- limited friction base isolation system," Zhendong yu Chongji/Journal of Vibration and Shock, vol. 30, pp. 148-152, 2011.
4) G. Sun and A. Li, "Dynamic reliability analysis and parameter optimization of base isolation structure," Journal of Southeast University (Natural Science Edition), vol. 39, pp. 320-7, 2009.
5) Chia-Ming, C. and Spencer Jr., B. F. (2010). "An Experimental Study of Active Base Isolation Control for Seismic Protection," in Sensors and Smart Structures Technologies for Civil, Mechanical, and Aerospace Systems, 8-11 March, USA, p. 76473V (12 pp.).
6) Chandak N. R. “Effect of Base Isolation on the Response of Reinforced Concrete Building”. Journal of Civil Engineering Research 2013, 3(4): 135-142.
7) Jangid, R.S. and Kelly, J. M., “base isolation for near-fault motions Earthquake Engineering Structure Dynamic”, 2001, 30, 691–707.
8) Sarvesh K Jain And Shashi K Thakkar “Seismic Response Of Building Base Isolated With Filled Rubber Bearings FLEX Chip Signal Processor (MC68175/D), Motorola, 1996.
9) ETABS Version 9.70 (1997), Computers and Structures, Inc., Berkeley, California. International Code Council, Inc. (2000). International Building Code.
10) A.B.M. Saiful Islam, Mohammed Jameel and Mohd Zamin Jumaat, ‘Seismic isolation in buildings to be a practical reality: Behavior of structure and installation technique’, Journal of Engineering and Technology Research Vol. 3(4), 99-117, April 2011.
11) Tustomu Hanai, Shinji Nakata, Shin-ichi Kiriyama, and Nobuo Fukuwa, ‘Coparison of seismic performance of base-isolated house with various decvices’, 13th World Conference on Earthquake Engineering, Vancouver, B.C., Canada, August 1-6, 2004, Paper No. 1203.
12) Farzad Naeim and James M. Kelly, Design of seismic isolated structures from theory to practice , JOHN WILEY & SONS, INC., Canada 1999.
13) Y. Ribakvo and I. Iskhakov, ‘Experimental Methods for Selecting Base Isolation Parameters for Public Buildings’, The open construction and building technology Journal, 2,1-6,2008.